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Theoretical Study of Non-equilibrium Ionization  
in the Presence of Electric and Magnetic Fields

Progress Report No. 3

for the period February 1, 1964 - July 31, 1964

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Prepared by

H. A. HASSAN

Project Director

Department of Mechanical Engineering

North Carolina State of the University of North Carolina

at Raleigh, North Carolina

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REPORTS CONTROL No. 2

During the period February 1, 1964 to July 31, 1964, two publications have appeared (References 1 and 2). A paper entitled <sup>3</sup> "Experiments with a Co-axial Hall Current Plasma Accelerator" will be presented at the Fourth Electric Propulsion Conference. In addition a joint NASA technical note <sup>4</sup> is being typed at the NASA Langley Research Center and will appear in the near future.

During this period a major effort has been devoted to the prediction of thrust from plasma accelerators. The case of the co-axial plasma accelerator has been considered and an attempt to predict the thrust using a one-dimensional analysis has been undertaken. The results of the analysis proved to be rather unsatisfactory because of the bulging of currents. As a result of bulging,  $E_x$ , the component of  $\vec{E}$  in the direction of acceleration, changes sign, and no suitable average of  $E_x$  can be obtained which would bring out the important features of the acceleration mechanism.

The one-dimensional analysis showed, however, that in regions not dominated by viscous stresses, the Hall effect is much more important than conversion of rotation into directed motion as an acceleration mechanism. Thus, the thrust is due mainly to conversion of thermal energy into directed energy and to the Hall effect.

In addition to the above work has continued on the analysis of non-equilibrium ionization in Linear Hall current accelerators and heat transfer in Co-axial Hall current accelerators in the presence of non-equilibrium ionization. The latter is being prepared for numerical calculations and, because of the convergence difficulties we are encountering with the former, no results regarding this problem are available at present.

ALL INFORMATION CONTAINED  
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Plans for Future Research

Work on the non-equilibrium ionization in linear Hall current accelerators and heat transfer in co-axial Hall current accelerators in the presence of non-equilibrium ionization will continue. In addition a two or three dimensional analysis of plasma accelerators will be undertaken in an effort to predict thrust.

1. Hassan, H. A., "On the Stress Tensor of a Partially Ionized Gas in the Presence of Electric and Magnetic Fields", Plasma Physics - Accelerators - Thermonuclear Research (Journal of Nuclear Energy Part C), vol. 6, pp. 289-293, 1964.
2. Hassan, H. A., "On the Transport Properties of a Partially Ionized Gas in the Presence of Electric and Magnetic Fields", NASA TN D - 2369, July, 1964.
3. Grossmann, W., Hassan, H. A., Hess, R. V. and Oertel, G., "Experiments with a Co-axial Hall Current Plasma Accelerator", AIAA Bulletin, vol. 1, no. 7, p. 388, 1964.
4. Grossmann, W., Hassan, H. A. and Hess, R. V., "Theory and Experiment of Arc Discharges Crossed with Magnetic Fields at High Pressures", To appear as a NASA Technical Note.